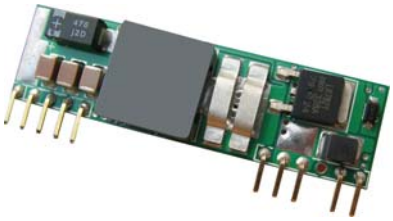
NON-ISOLATED DC/DC CONVERTERS

4.5 V - 13.2 V Input 0.9 V - 5.0 V/15 A Output

VRPB-15E Series RoHS Compliant

- Non-Isolated
- High Efficiency
- High Power Density
- Low Cost
- Excellent Thermal Performance
- Remote On/Off
- Active Low/High (option)
- Over Temperature Protection
- Under-voltage Lockout (UVLO)
- OCP/SCP
- Remote Sense
- Industrial Temperature Range
- Wide Input Voltage Range
- Wide Output Trim Range



Description

The Bel VRPB-15Exxx series are part of the low cost non-isolated dc/dc power converter series. These modules use a SIP package for ease of layout and space savings. The output is closely regulated and the efficiency at 3.3 V output is typically 92% at full load. Typical features include remote on/off, under-voltage lockout, wide input voltage range, wide output trim range, over-current protection and short circuit protection.

Part Selection

Output Voltage	Input Voltage	Max. Output Current	Max. Output Power	Typical Efficiency	Model Number Active Low	Model Number Active High
5.0 V	8.0 V - 13.2 V	15 A	75.0 W	92.6%	VRPB-15E50L	VRPB-15E50S
3.3 V	4.5 V - 13.2 V	15 A	48.5 W	92%	VRPB-15E33L	VRPB-15E33S
2.5 V	4.5 V - 13.2 V	15 A	37.5 W	90%	VRPB-15E25L	VRPB-15E25S
1.8 V	4.5 V - 13.2 V	15 A	27.0 W	88%	VRPB-15E18L	VRPB-15E18S
1.5 V	4.5 V - 13.2 V	15 A	22.5 W	86%	VRPB-15E15L	VRPB-15E15S
1.2 V	4.5 V - 13.2 V	15 A	18.0 W	84%	VRPB-15E12L	VRPB-15E12S
0.9 V	4.5 V - 13.2 V	15 A	13.5 W	80%	VRPB-15E09L	VRPB-15E09S
0.9 V - 3.63 V	4.5 V - 13.2 V	15 A	54.5 W	92%	VRPB-15E1AL	VRPB-15E1AS

Note: Add “G” suffix at the end of the model number to indicate “Tray Packaging”.

Absolute Maximum Ratings

Parameter	Min	Typ	Max	Notes
Input Voltage (continuous)	-0.3 V	-	15 V	
Output Enable Terminal Voltage	-0.3 V	-	15 V	
Ambient Temperature	-40 °C	-	85 °C	
Storage Temperature	-40 °C	-	125 °C	

NON-ISOLATED DC/DC CONVERTERS

4.5 V - 13.2 V Input 0.9 V - 5.0 V/15 A Output

Input Specifications

Parameter	Min	Typ	Max	Notes
Input Voltage				
0.9V≤Vo≤3.63 V	4.5 V	-	13.2 V	
Vo>3.63 V	8.0 V	-	13.2 V	
Input Current (full load)				
Vo=3.3 V	-	-	11.4 A	
Vo=2.5 V	-	-	9.0 A	
Vo=1.8 V	-	-	6.7 A	Vin=5 V
Vo=1.5 V	-	-	5.8 A	
Vo=1.2 V	-	-	4.9 A	
Vo=0.9 V	-	-	3.9 A	
Input Current (full load)				
Vo=5.0 V	-	-	11.2 A	
Vo=3.3 V	-	-	4.9 A	
Vo=2.5 V	-	-	3.6 A	
Vo=1.8 V	-	-	2.7 A	Vin=12 V
Vo=1.5 V	-	-	2.3 A	
Vo=1.2 V	-	-	1.9 A	
Vo=0.9 V	-	-	1.49 A	
Input Current (no load)				
Vo=3.3 V	-	-	180 mA	
Vo=2.5 V	-	-	180 mA	
Vo=1.8 V	-	-	180 mA	Vin=5 V
Vo=1.5 V	-	-	175 mA	
Vo=1.2 V	-	-	170 mA	
Vo=0.9 V	-	-	165 mA	
Input Current (no load)				
Vo=5.0 V	-	-	210 mA	
Vo=3.3 V	-	-	160 mA	
Vo=2.5 V	-	-	140 mA	
Vo=1.8 V	-	-	120 mA	Vin=12 V
Vo=1.5 V	-	-	120 mA	
Vo=1.2 V	-	-	110 mA	
Vo=0.9 V	-	-	105 mA	
Input Reflected Ripple Current (pk-pk)	-	-	600 mA	Tested with simulated source impedance of 500 nH and one 470 uF/25 V AL. capacitor. with ESR=0.03 ohm max and two 270 uF/16 V Oscon capacitor. with ESR=0.013 ohm max at 100 kHz
Input Reflected Ripple Current (rms)	-	-	250 mA	
I^2t Inrush Current Transient	-	0.04 A^2s	0.08 A^2s	
Turn-on Voltage Threshold	-	3.9 V	-	0.9V≤Vo≤3.63V
Turn-off Voltage Threshold	-	2.5 V	-	
Turn-on Voltage Threshold	-	5.3 V	-	Vo>3.63 V
Turn-off Voltage Threshold	-	4.5 V	-	

Output Specifications

Parameter	Min	Typ	Max	Notes
Output Voltage Set Point				
Vo=5.0 V	4.900 V	5.0 V	5.100 V	
Vo=3.3 V	3.234 V	3.3 V	3.366 V	
Vo=2.5 V	2.450 V	2.5 V	2.550 V	Test condition:
Vo=1.8 V	1.764 V	1.8 V	1.836 V	Vin=12 V, Iout=full load
Vo=1.5 V	1.470 V	1.5 V	1.530 V	
Vo=1.2 V	1.176 V	1.2 V	1.224 V	
Vo=0.9 V	0.882 V	0.9 V	0.918 V	

Output Specifications (continued)

Parameter	Min	Typ	Max	Notes
Load Regulation				
Vo=5.0 V	-	15 mV	40 mV	
Vo=3.3 V	-	10 mV	20 mV	
Vo=2.5 V	-	8 mV	20 mV	
Vo=1.8 V	-	6 mV	15 mV	
Vo=1.5 V	-	5 mV	15 mV	
Vo=1.2 V	-	5 mV	15 mV	
Vo=0.9 V	-	5 mV	15 mV	
Line Regulation				
Vo=5.0 V	-	15 mV	35 mV	
Vo=3.3 V	-	10 mV	20 mV	
Vo=2.5 V	-	7 mV	15 mV	
Vo=1.8 V	-	5 mV	10 mV	
Vo=1.5 V	-	3 mV	10 mV	
Vo=1.2 V	-	3 mV	10 mV	
Vo=0.9 V	-	3 mV	10 mV	
Regulation Over Temperature (-40 °C to +85 °C)				
Vo=5.0 V	-	40 mV	80 mV	
Vo=3.3 V	-	15 mV	30 mV	
Vo=2.5 V	-	10 mV	20 mV	
Vo=1.8 V	-	5 mV	15 mV	
Vo=1.5 V	-	5 mV	15 mV	
Vo=1.2 V	-	5 mV	15 mV	
Vo=0.9 V	-	2 mV	10 mV	
Output Current	0 A	-	15 A	
Current Limit Threshold	18 A	-	45 A	
Short Circuit Surge Transient				
Vo=5.0 V	-	4.5 A^2s	9 A^2s	
Vo=3.3 V	-	3.9 A^2s	7.8 A^2s	
Vo=2.5 V	-	3 A^2s	6 A^2s	
Vo=1.8 V	-	3 A^2s	6 A^2s	
Vo=1.5 V	-	3 A^2s	6 A^2s	
Vo=1.2 V	-	3 A^2s	6 A^2s	
Vo=0.9 V	-	2.5 A^2s	5 A^2s	
Turn on Time				
Vo=5.0 V	-	280 mS	310 mS	
Vo=3.3 V	-	280 mS	310 mS	
Vo=2.5 V	-	240 mS	270 mS	
Vo=1.8 V	-	220 mS	250 mS	
Vo=1.5 V	-	200 mS	230 mS	
Vo=1.2 V	-	190 mS	220 mS	
Vo=0.9 V	-	170 mS	200 mS	
Overshoot at Turn on	-	-	5%Vo,set	
Output Capacitoracitance	-	-	6800 uF	
Output Ripple and Noise (pk-pk)				
Vo=5.0 V	-	60 mV	100 mV	Test conditions: 0-20 MHz BW; 22 uF tantalum capacitor at the output
Vo=3.3 V	-	60 mV	100 mV	
Vo=2.5 V	-	50 mV	90 mV	
Vo=1.8 V	-	40 mV	80 mV	
Vo=1.5 V	-	40 mV	80 mV	
Vo=1.2 V	-	30 mV	70 mV	
Vo=0.9 V	-	20 mV	60 mV	

Output Specifications (continued)

Parameter		Min	Typ	Max	Notes
Output Ripple and Noise (rms)					
	Vo=5.0 V	-	25 mV	50 mV	Test conditions: 0-20 MHz BW; 22 uF tantalum capacitor at the output
	Vo=3.3 V	-	20 mV	40 mV	
	Vo=2.5 V	-	15 mV	30 mV	
	Vo=1.8 V	-	10 mV	20 mV	
	Vo=1.5 V	-	10 mV	20 mV	
	Vo=1.2 V	-	10 mV	20 mV	
	Vo=0.9 V	-	5 mV	15 mV	
Transient Response (Vin=12 V)					
50% ~ 100% Max Load	Vo=5.0 V	-	150 mV	220 mV	Test conditions: di/dt=0.5 A/us, Vin=12.0 Vdc, and with a 470 uF tantalum capacitor at the output except Vo=5.0 V
Settling Time		-	60 uS	100 uS	
100% ~ 50% Max Load		-	150 mV	220 mV	
Settling Time		-	60 uS	100 uS	
50% ~ 100% Max Load	Vo=3.3 V	-	80 mV	120 mV	
Settling Time		-	60 uS	100 uS	
100% ~ 50% Max Load		-	80 mV	120 mV	
Settling Time		-	60 uS	100 uS	
50% ~ 100% Max Load	Vo=0.9 V - 2.5 V	-	70 mV	120 mV	
Settling Time		-	60 uS	90 uS	
100% ~ 50% Max Load		-	70 mV	120 mV	
Settling Time		-	60 uS	90 uS	
Transient Response (Vin=5 V)					
50% ~ 100% Max Load	Vo=0.9 V - 3.3 V	-	120 mV	160 mV	Test conditions: di/dt = 0.5 A/uS; Vin =5 V; with one 470 uF tantalum capacitor at the output
Settling Time		-	70 uS	120 uS	
100% ~ 50% Max Load		-	120 mV	160 mV	
Settling Time		-	70 uS	120 uS	

Note: All specifications are typical at 25 °C unless otherwise stated.

General Specifications

Parameter	Min	Typ	Max	Notes
Efficiency				
Vo=5.0 V	88%	92.6%	-	Measured at Vin=12 V, full load.
Vo=3.3 V	87%	92%	-	
Vo=2.5 V	85%	90%	-	
Vo=1.8 V	83%	88%	-	
Vo=1.5 V	81%	86%	-	
Vo=1.2 V	79%	84%	-	
Vo=0.9 V	75%	80%	-	
Efficiency				
Vo=3.3 V	88%	93%	-	Measured at Vin=5 V, full load.
Vo=2.5 V	86%	91%	-	
Vo=1.8 V	83%	88%	-	
Vo=1.5 V	81%	86%	-	
Vo=1.2 V	79%	83%	-	
Vo=0.9 V	75%	81%	-	
Switching Frequency	180 kHz	200 kHz	220 kHz	
Output Voltage Trim Range (Wide Trim)	-	-	403%Vo	VRPB-15E1Ax
Output Voltage Trim Range (Narrow Trim)				VRPB-15Exxx
Vo=1.2 V-5.0 V	90%Vo	-	110%Vo	
Vo=0.9 V	-	-	110%Vo	
Remote Sense Compensation	-	-	10%Vo	
MTBF	3,714,560 hours			Calculated Per Bell Core SR-332 (I_O = 80%Iomax; Vo=1.8 V; Vin=12 V; T_a = 25 °C)
Dimensions				
Inches (L × W × H)	2.0 x 0.55 x 0.36			
Millimeters (L × W × H)	50.8 x 13.97 x 9.14			
Weight	-	10 g	-	

Note: All specifications are typical at 25 °C unless otherwise stated.

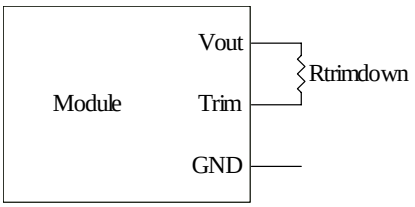
Control Specifications

Parameter	Min	Typ	Max	Notes
Remote On/Off				
Signal Low (Unit Off)	-0.3 V	-	0.4 V	VRPB-15ExxS
Signal High (Unit On)	2.8 V	-	13.2 V	
Signal Low (Unit On)	-0.3 V	-	0.4 V	VRPB-15ExxL
Signal High (Unit Off)	2.8 V	-	13.2 V	

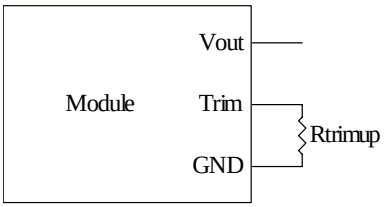
Output Trim Equations

Equations for calculating the trim resistor (in kΩ) given the desired adjusted voltage (Vadj) and the nominal output voltage of the converter (Vnom) are shown below. The Trim Down resistor should be connected between the Trim pin and Vout. The Trim Up resistor should be connected between the Trim pin and Ground. Only one of the resistors should be used for any given application.

$$R_{TrimDown} = \frac{A}{V_{nom} - V_{adj}} - B$$

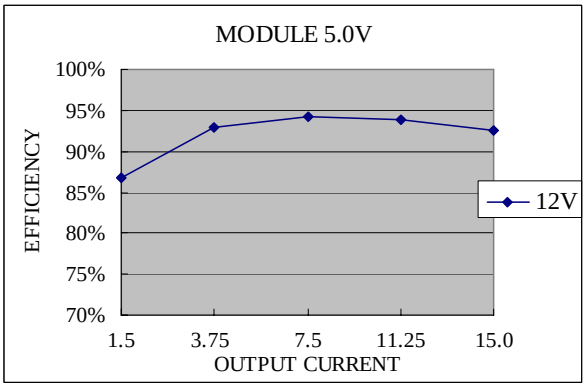


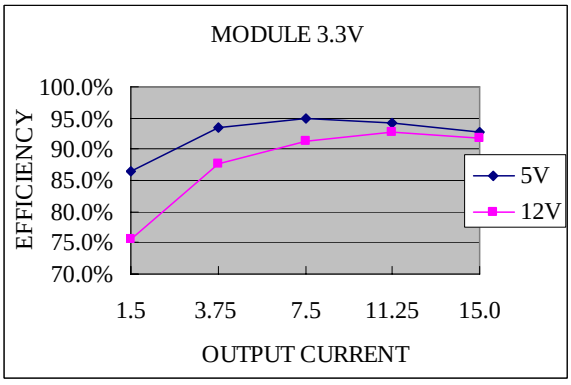
$$R_{TrimUp} = \frac{C}{V_{adj} - V_{nom}} - D$$



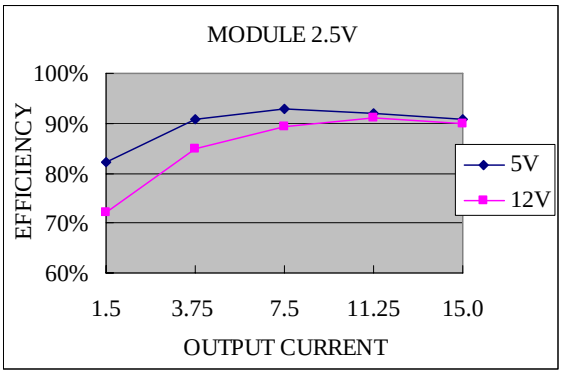
Vnom	A	B	C	D
0.9 - 3.63	N/A	N/A	6.008	2.150
5.0	31.574	19.010	6.008	11.50
3.3	18.8157	25.310	6.008	17.800
2.5	12.7927	30.110	6.008	22.600
1.8	7.5426	39.110	6.008	31.600
1.5	5.2865	33.610	6.008	26.100
1.2	3.027	24.410	6.008	16.900
0.9	N/A	N/A	6.008	64.900

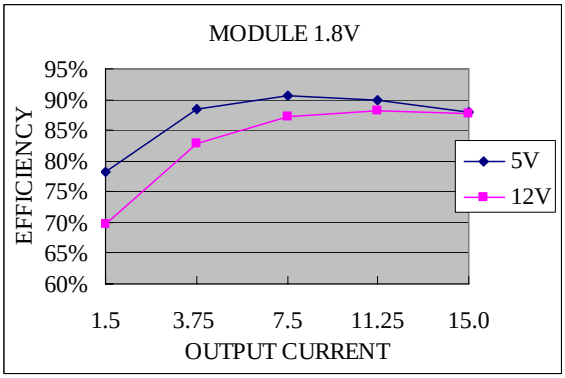
Efficiency Data

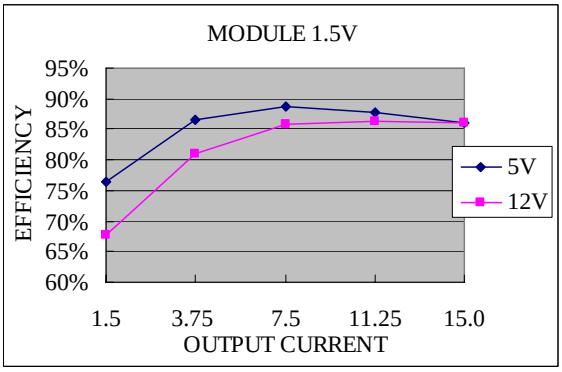


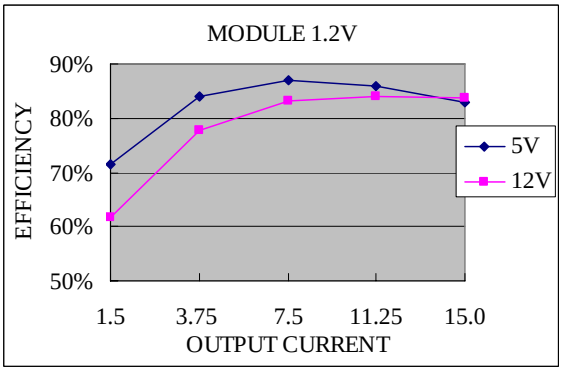


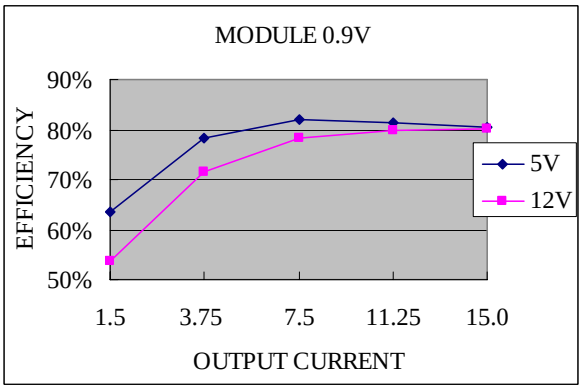
Efficiency Data (continued)



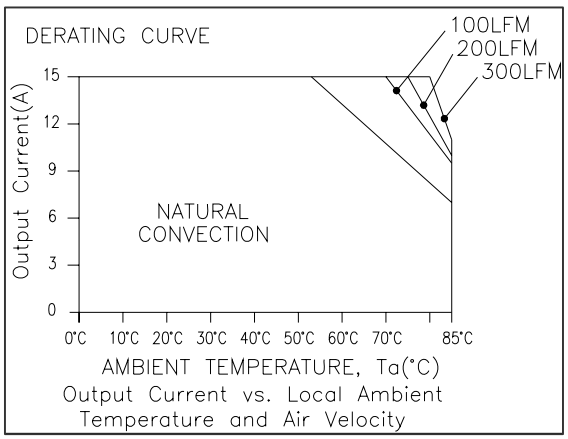




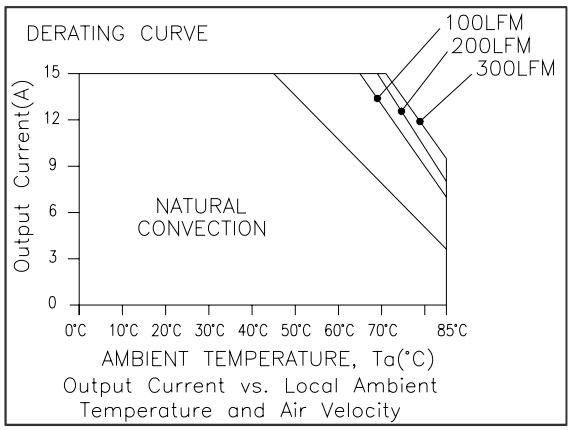




Thermal Derating Curves



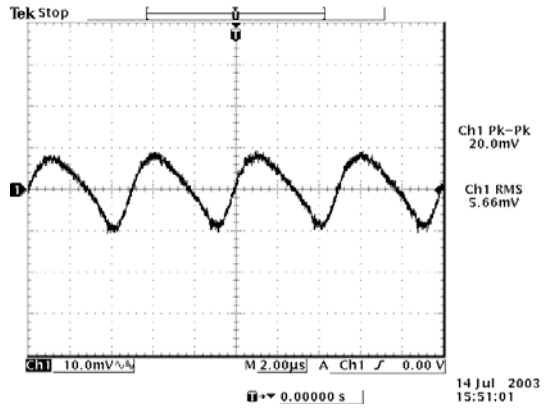
(Vin=5.5 V, Vo=3.3 V)



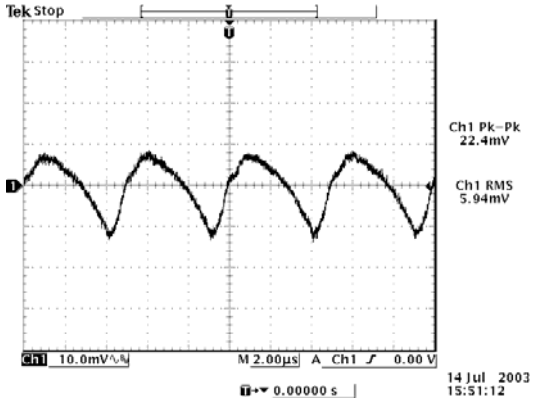
(Vin=13.2 V, Vo=3.3 V)

Ripple and Noise

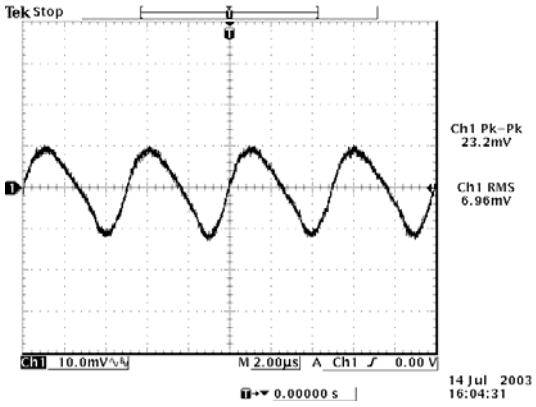
Ripple and noise at full load, external load with 22 uF tantulm capacitor at the output, and Ta=25 deg C.



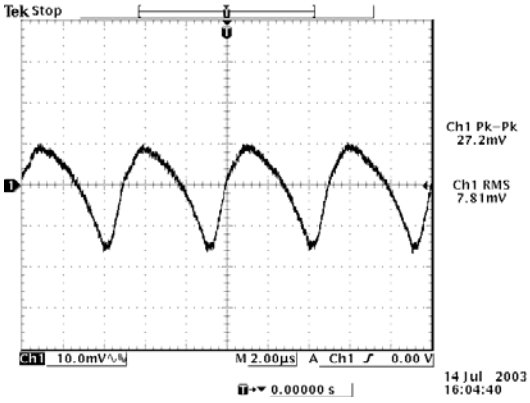
Vin=5 V, Vo=0.9 V



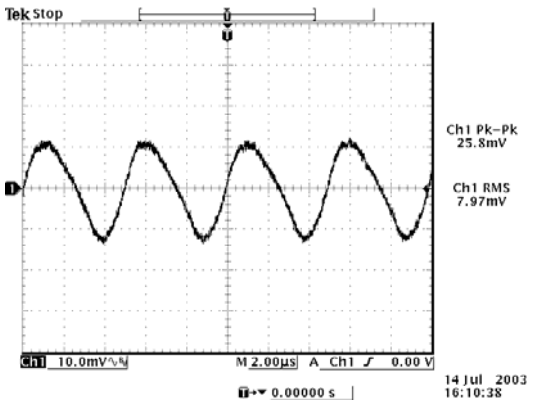
Vin=12 V, Vo=0.9 V



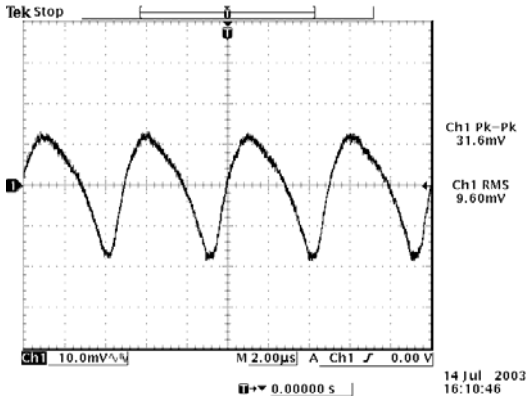
Vin=5 V, Vo=1.2 V



Vin=12 V, Vo=1.2 V

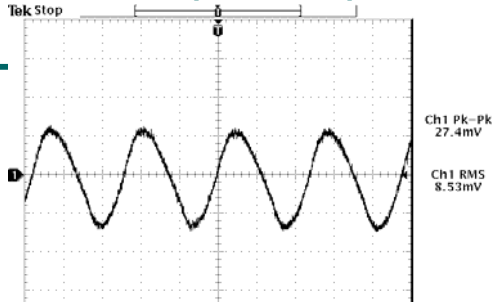


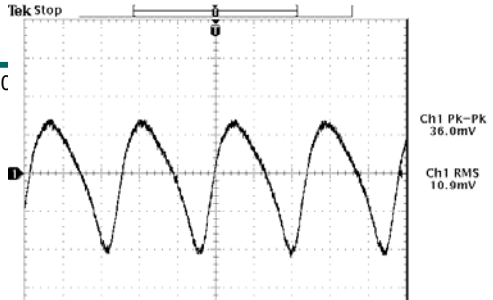
Vin=5 V, Vo=1.5 V



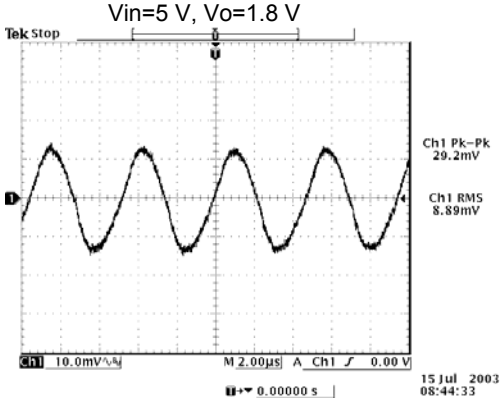
Vin=12 V, Vo=1.5 V

Ripple and Noise (continued)

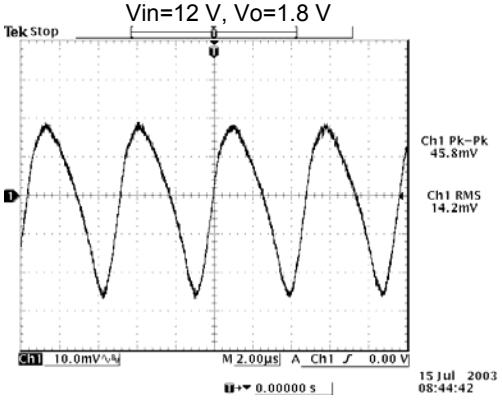




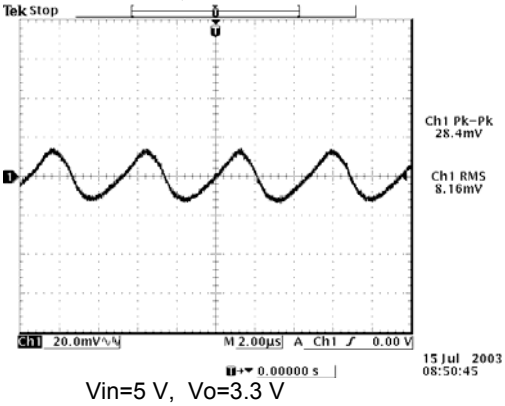
Vin=5 V, Vo=1.8 V



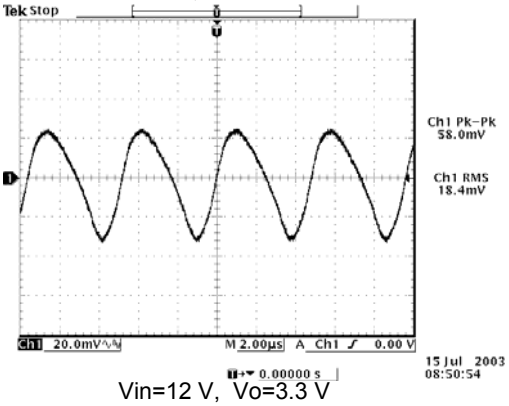
Vin=12 V, Vo=1.8 V



Vin=5 V, Vo=2.5 V

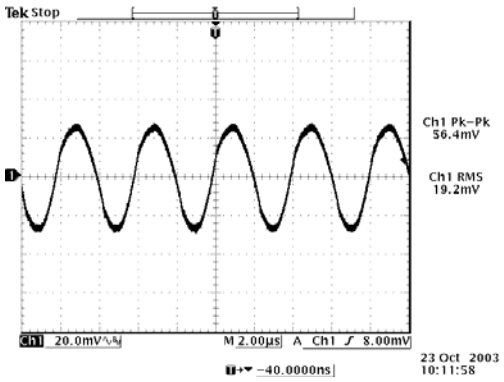


Vin=12 V, Vo=2.5 V



Vin=5 V, Vo=3.3 V

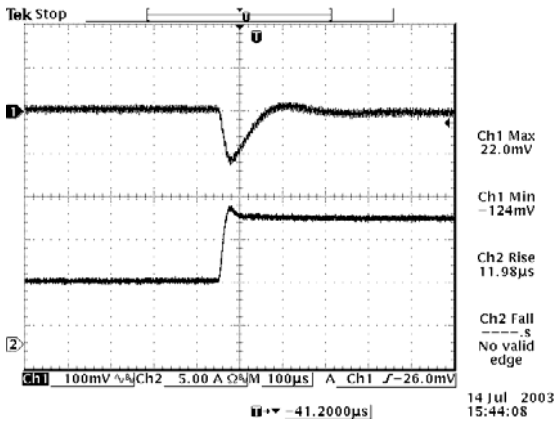
Vin=12 V, Vo=3.3 V



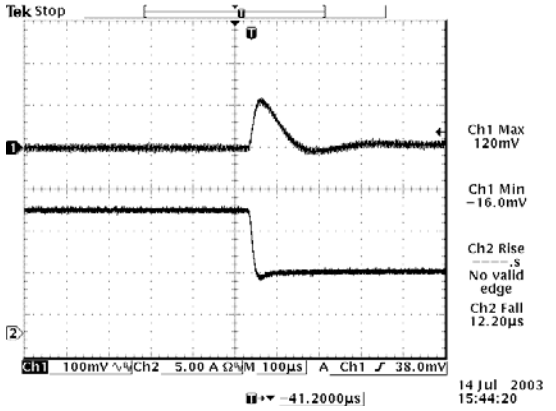
Vin=12 V, Vo=5 V

Transient Response

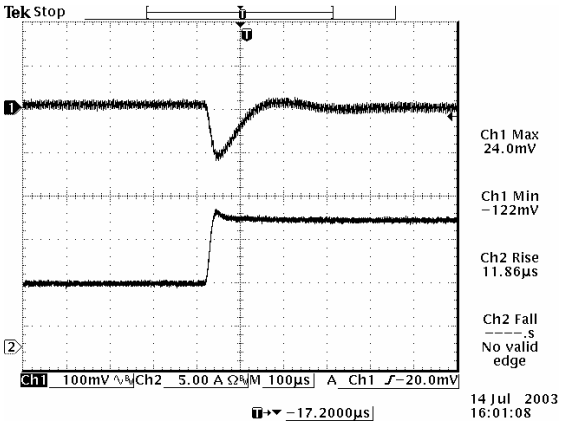
Transient response: di/dt=0.5 A/uS, external load capacitance Co=470 uF (tantalum capacitor), Ta=25 ℃ .



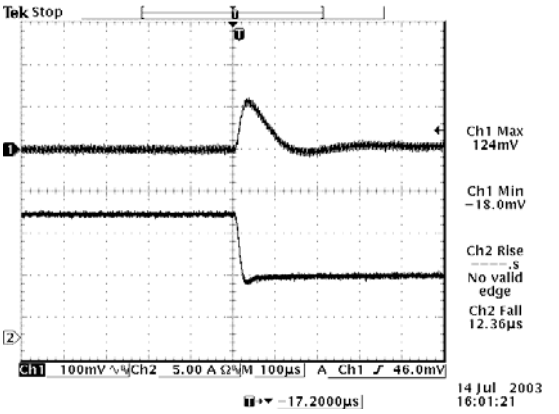
50% to 100% load Transient at Vin=5 V, Vo=0.9 V



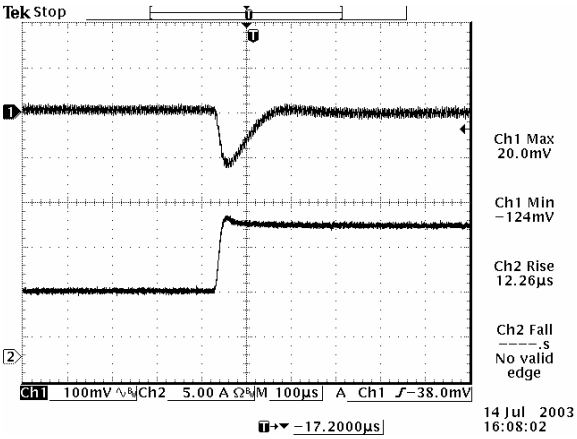
100% to 50% load Transient at Vin=5 V, Vo=0.9 V



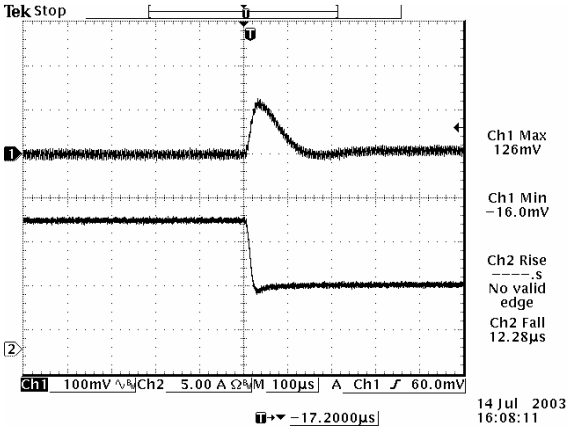
50% to 100% load Transient at Vin=5 V, Vo=1.2 V



100% to 50% load Transient at Vin=5 V, Vo=1.2 V

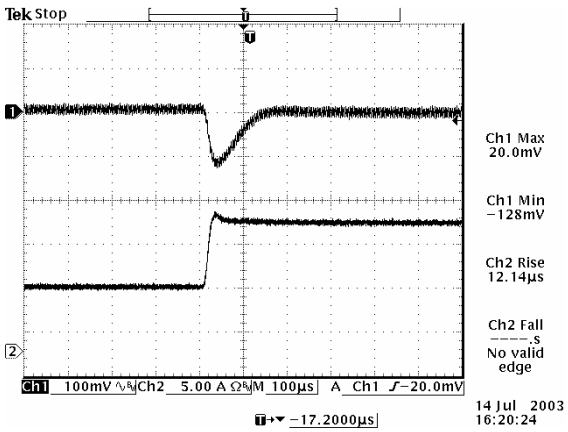


50% to 100% load Transient at Vin=5 V, Vo=1.5 V

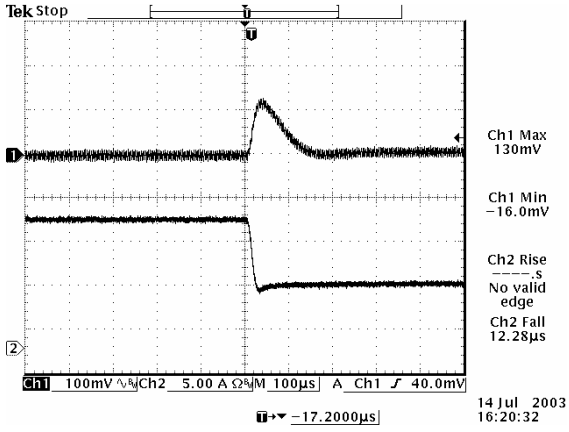


100% to 50% load Transient at Vin=5 V, Vo=1.5 V

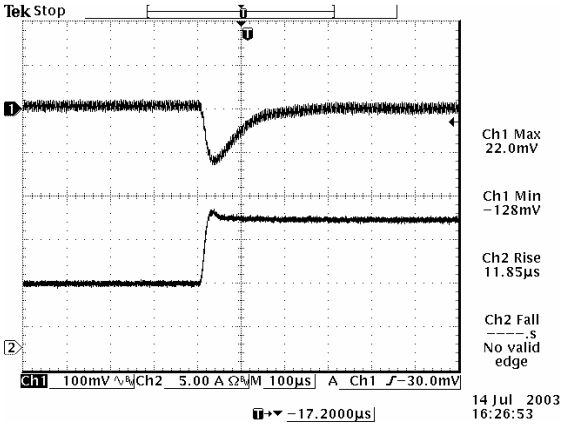
Transient Response (continued)



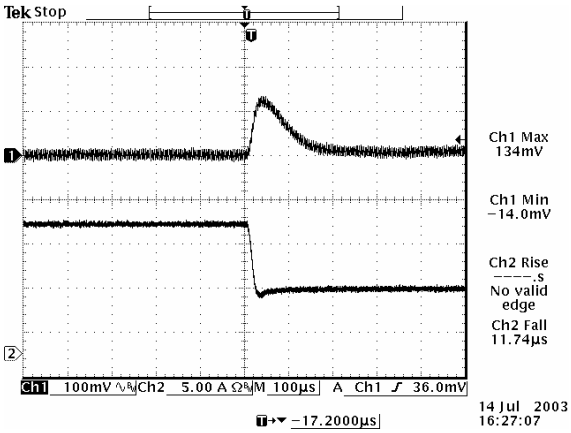
50% to 100% load Transient at Vin=5 V, Vo=1.8 V



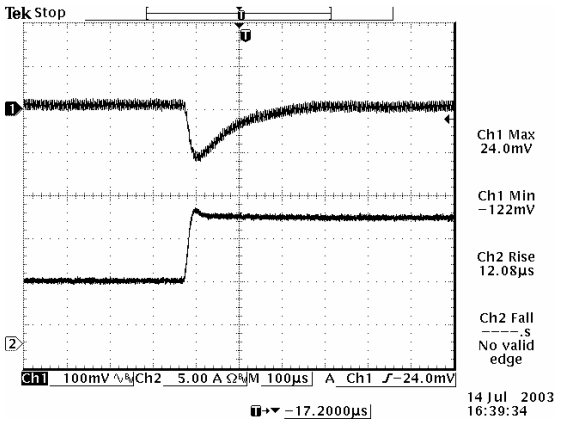
100% to 50% load Transient at Vin=5 V, Vo=1.8 V



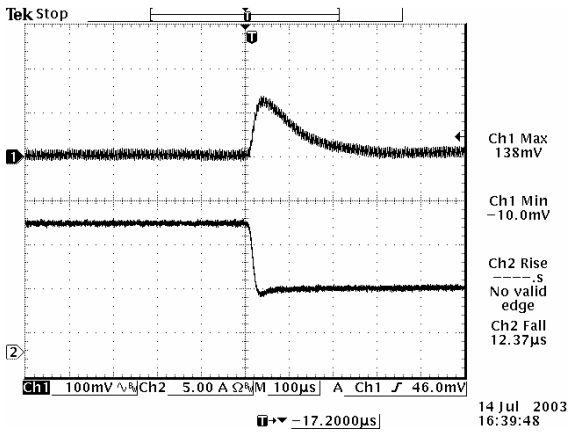
50% to 100% load Transient at Vin=5 V, Vo=2.5 V



100% to 50% load Transient at Vin=5 V, Vo=2.5 V

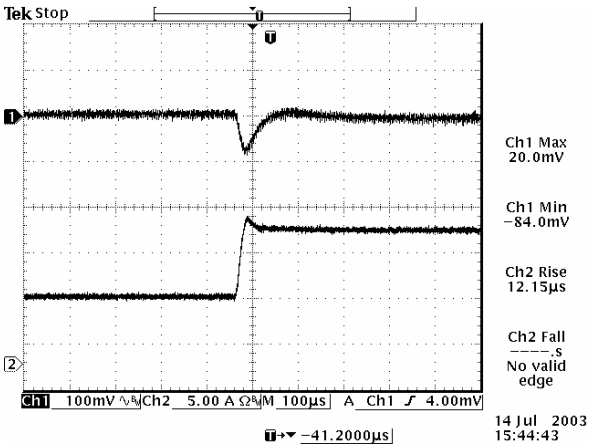


50% to 100% load Transient at Vin=5 V, Vo=3.3 V

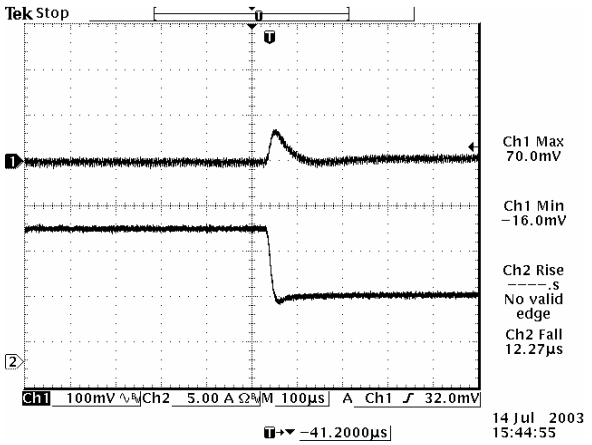


100% to 50% load Transient at Vin=5 V, Vo=3.3 V

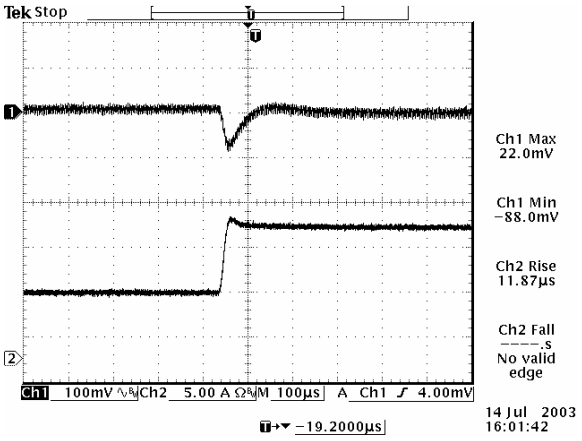
Transient Response (continued)



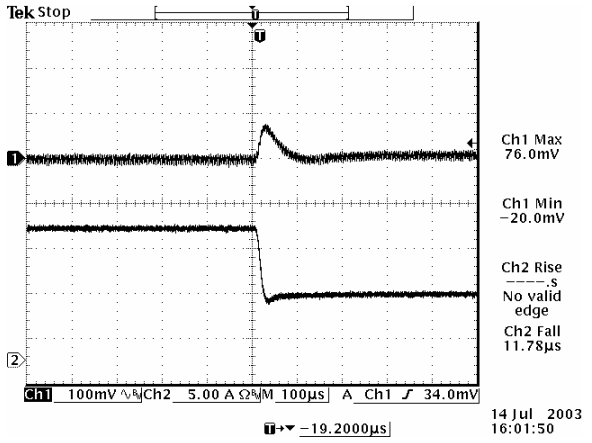
50% to 100% load Transient at Vin=12 V, Vo=0.9 V



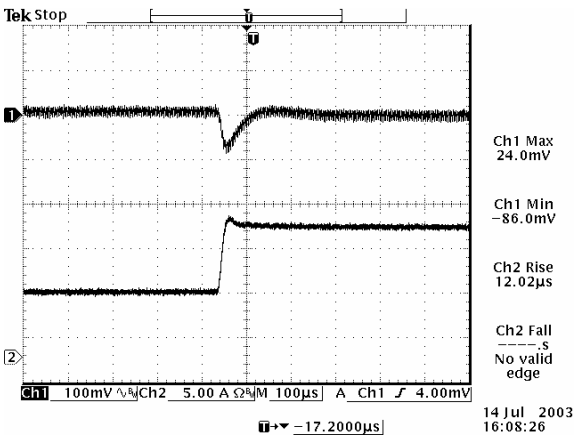
100% to 50% load Transient at Vin=12 V, Vo=0.9 V



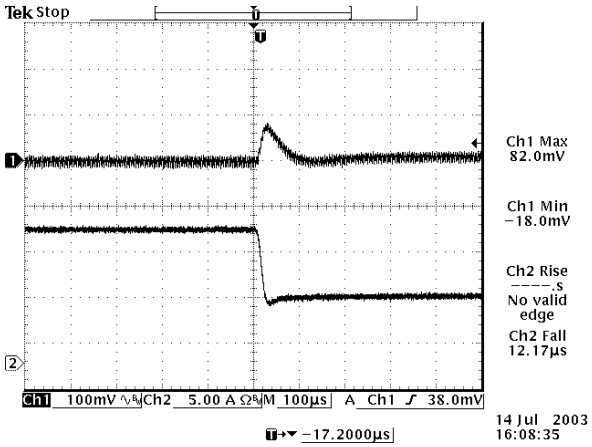
50% to 100% load Transient at Vin=12 V, Vo=1.2 V



100% to 50% load Transient at Vin=12 V, Vo=1.2 V

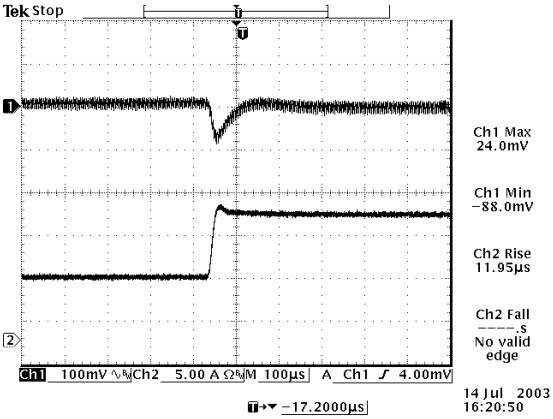


50% to 100% load Transient at Vin=12 V, Vo=1.5 V

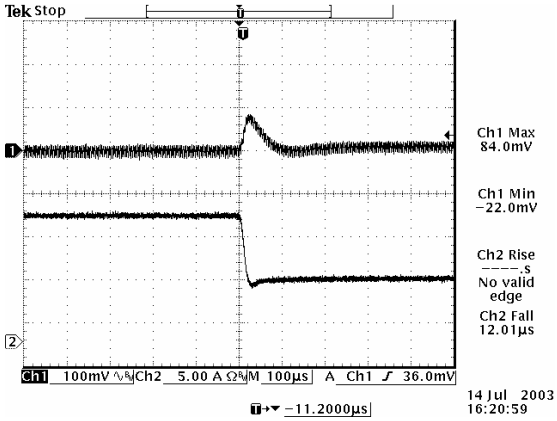


100% to 50% load Transient at Vin=12 V, Vo=1.5 V

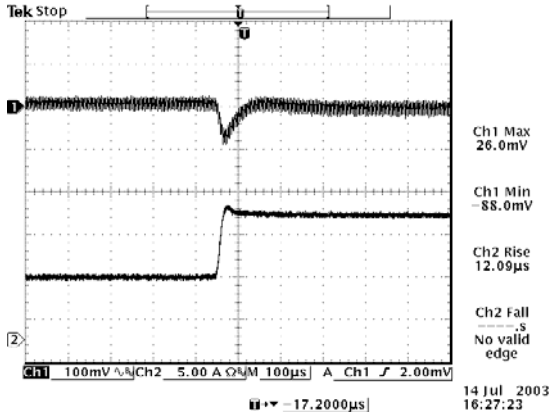
Transient Response (continued)



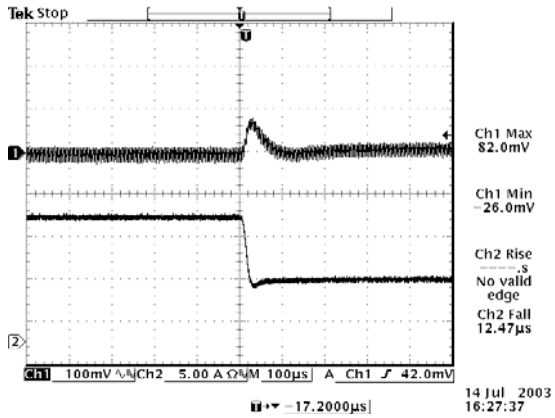
50% to 100% load Transient at Vin=12 V, Vo=1.8 V



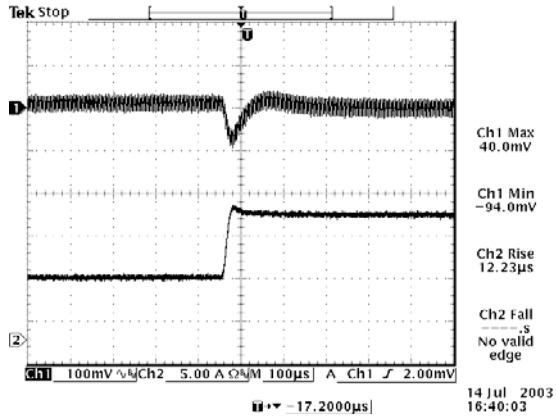
100% to 50% load Transient at Vin=12 V, Vo=1.8 V



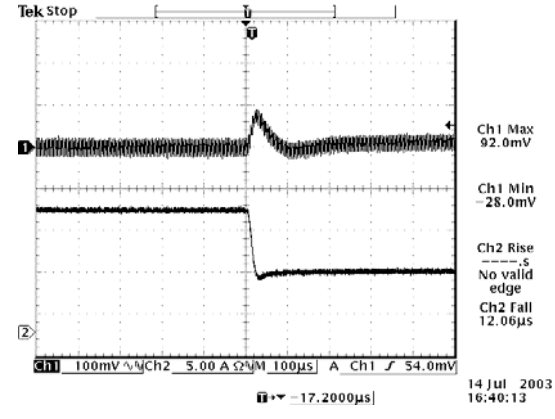
50% to 100% load Transient at Vin=12 V, Vo=2.5 V



100% to 50% load Transient at Vin=12 V, Vo=2.5 V



50% to 100% load Transient at Vin=12 V, Vo=3.3 V

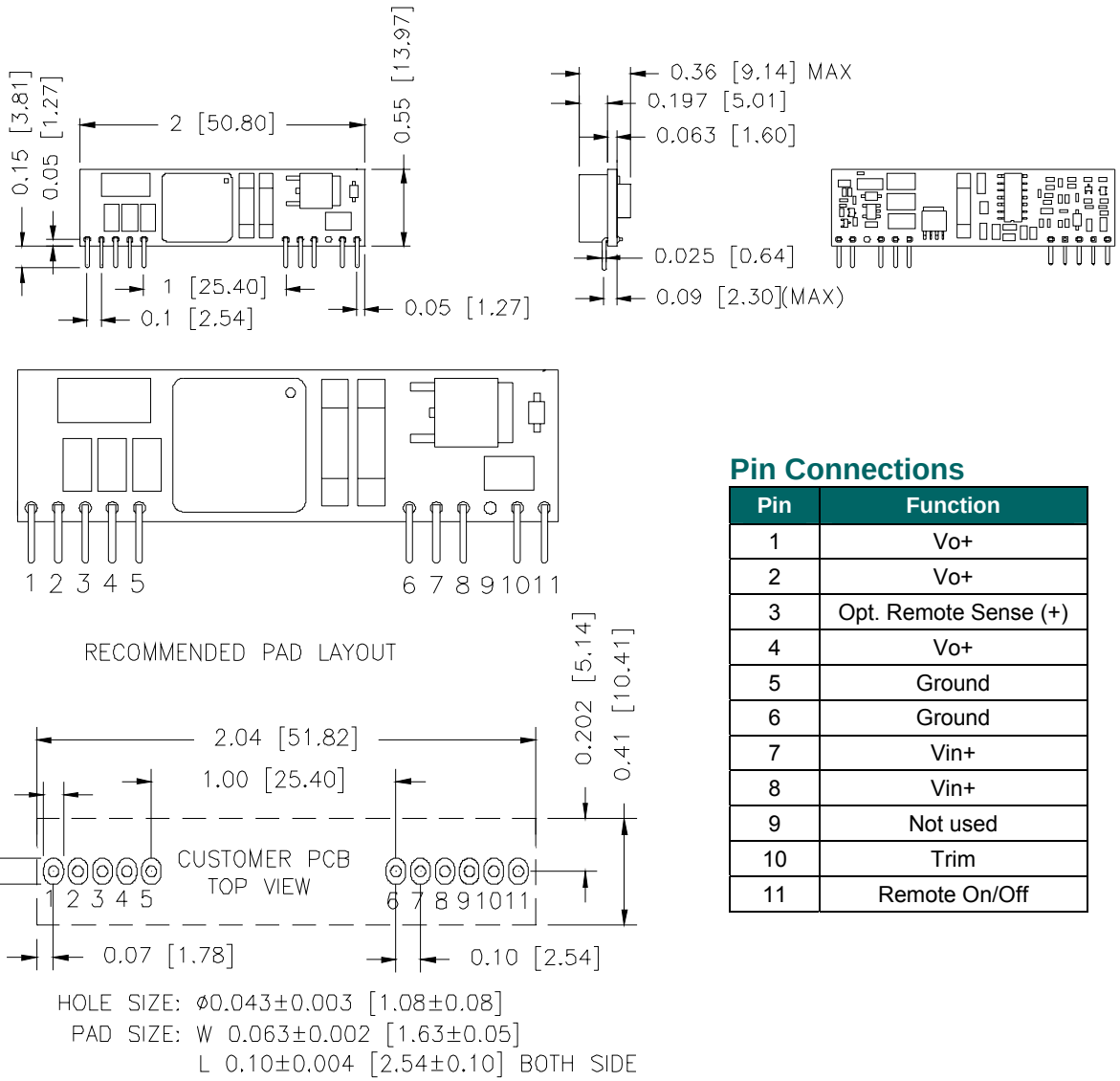


100% to 50% load Transient at Vin=12 V, Vo=3.3 V

NON-ISOLATED DC/DC CONVERTERS

4.5 V - 13.2 V Input 0.9 V - 5.0 V/15 A Output

Mechanical Outline



Pin Connections

Pin	Function
1	Vo+
2	Vo+
3	Opt. Remote Sense (+)
4	Vo+
5	Ground
6	Ground
7	Vin+
8	Vin+
9	Not used
10	Trim
11	Remote On/Off

RoHS Compliance

Complies with the European Directive 2002/95/EC, calling for the elimination of lead and other hazardous substances from electronic products.

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CORPORATE

Bel Fuse Inc.
206 Van Vorst Street
Jersey City, NJ 07302
Tel 201-432-0463
Fax 201-432-9542
www.belfuse.com

FAR EAST

Bel Fuse Ltd.
8F/ 8 Luk Hop Street
San Po Kong
Kowloon, Hong Kong
Tel 852-2328-5515
Fax 852-2352-3706
www.belfuse.com

EUROPE

Bel Fuse Europe Ltd.
Preston Technology Management Centre
Marsh Lane, Suite G7, Preston
Lancashire, PR1 8UD, U.K.
Tel 44-1772-556601
Fax 44-1772-888366
www.belfuse.com